Morphological and anatomical studies of *Iris iberica* subsp. *elegantissima* and *Iris sintenisii* (*Iridaceae*) from Turkey

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Abstract. The species of genus *Iris* (*Iridaceae*) are extensively grown as ornamental plants in home and botanical gardens. In this study, the morphological and anatomical properties of *I. iberica*. subsp. *elegantissima* and *I. sintenisii* are investigated. The cross-sections of root, scape and leaf parts of the plant are examined and demonstrated by photographs. In the anatomical studies, the wall thickenings of the endodermal cells are found to be three-sided. Leaf features, such as papillae, metaxylem number in the root and arrangement of vascular bundles can be used as distinguishing characters for the *Iris* species. Most anatomical properties are similar to the other members of *Iridaceae* family.

Key words: anatomy, *Iris, Iridaceae*, morphology, Turkey

Introductıon

Iridaceae is a large and diverse family of about 80 genera, for mainly the central continents in the southern hemisphere. The family is typically characterized by isobilateral equitant leaves and epigynous flowers with three stamens (Rudall 1994). Genus *Iris* is member of the *Iridaceae* family. According to Flora of Turkey, the genus *Iris* is represented by 44 taxa in Turkey (Davis 1984; Güner & al. 2000).

The species of *Iris* are perennial herbaceous plants, with rhizomatous or bulbous underground scape. These plants are economically important, since they are used in decoration and medicine. Drugs obtained from the rhizomes of these species are applied to cure upper respiratory syscape infections, and to prevent teething problems in babies; the rhizomes are also used in perfumery (Baytop 1984). The species of *Iris* are grown prominently in gardens and parks and on the balconies (Baytop 1977).

Anatomy and morphology of the genus *Iris* and of other genera of the family *Iridaceae* are described in different scientific works (Rudall 1994, 1995, 2007; Nikolić & al. 2000). There are also some taxonomic studies of the genus *Iris* in Turkey (Güner & Peşmen 1980; Mathew 1984, 1989). However, there are few anatomical studies of this genus (Dönmez & Pınar 2001; Özdemir & al. 2007). The species *I. iberica* and *I. sintenisii* have not been studied, except for their description in the *Flora of Turkey* (Davis 1984). Thus these taxa have been investigated in this study in their morphological and anatomical aspects.

Material and methods

The material of *I. iberica* was collected from a natural population in May 2009, during the period of flowering. Plant specimens were taken in the Erzurum Province, at 2000 m a.s.l., by Yurdanur Aky-

ol. The material of *I.sintenisii* was collected from a natural population in June 2009, during flowering. Plant specimens were taken from Bolu, Abant, at 1000 m a.s.l., by Canan Özdemir. Fresh plant samples were used for the morphological measurements. The results of these measurements were compared with Davis (Davis 1984) and plant samples were described. For the anatomical studies, plant specimens were fixed in 70 % ethanol. The paraffin method was used for preparing cross sections of scape, leaves and root (Algan 1981). Transverse sections of 15–20 µm were cut with a rotary microtome and stained with safranin-Fast Green. Hand-cut sections were also made and stained with sartur reagent (Çelebioğlu & Baytop 1949).

Results

Morphological results

Iris iberica subsp. *elegantissima*

The plant 13–30 cm high. Rhizome compact, non-stoloniferous. Leaves 4–6, falcate, greyish-green, 0.2–0.6 cm wide. Bract and bracteole 3–7.2 cm, greenish, occasionally veined-brown. Falls heavily spotted and veined-brownish-purple on a white ground; standards pure white or slightly veined at base. Perianth tube 2–3.5 cm, falls broadly elliptic to ± orbicular, 3.5–6.5 × 2.7–6.5 cm, often emarginate, heavily veined and spotted-brownish-purple or deep-purple on a white ground, with an orbicular blackish or dark-brown signal spot in centre, and sparsely to densely bearded on claw, with a wide band of long purplish-brown hairs; standards ±orbicular, 4.5–8.5 × 3.5–7.4 cm, pure white or veined-brown or purple, occasionally as dense as falls; style branches 3–5.5 × 1.2–2.5 cm, with erect or reflexed crenulate lobes 0.8–2 × 0.7–1.8 cm. Capsule fusiform, 7–9 × 2–2.5 cm; seeds c. 5 mm, with a large white aril (Fig. 1A).

I. sintenisii

The plant 8–25 cm high. Rhizome horizontal, slender, clothed with brown fibrous leaf remains. Leaves linear, rather rigid and closely veined, 0.3–0.5 cm wide, equalling or slightly exceeding the flowers. Scape unbranched, l–2-flowered, often slightly zigzag at nodes. Bracts and bracteoles 3.5–6 cm. Flowers violet-blue, falls prominently veined on a whitish ground; falls 3.8–4.5 cm, lamina ovate-elliptic, 1.3–1.4 × 0.9–1.3 cm, narrowed to a claw 2.5–3 × 0.3–0.5 cm; standards oblanceolate, 3–4 × 0.4–0.5 cm; style branched 2.6–2.8 × 0.5–0.6 cm, with recurved lobes 0.2–0.3 × 0.2–0.3 cm. Ovary with a slender beak 1–2 cm, widening abruptly into the perianth tube. Capsule oblong, 1.5 × l cm, with a slender beak up to 2 cm (Fig. 1B).

Anatomical results

Iris iberica subsp. *elegantissima*

Root: The outer surface of *I. iberica* root is covered by a single-layered epidermis. Cortex is 17–20 layered. Intercellular spaces are absent between the parenchymatic cortex cells. Endodermis is single-layered. The wall thickenings of the endodermal cells are three-sided and oriented to pericyle. Pericycle is single-layered too and located under the endodermis. There are 30–35 metaxylems at the center of the root. Pith area is absent in the root cross section (Fig. 2A,B).

Scape: The outer surface of the scape is covered by a thick cuticle. Epidermis under the cuticle is single-layered. The 7–10 layered cortex parenchyma consists of parenchymatic cells. These cells are oval and circular in shape. Intercellular spaces are present in the cortex of the scape. Vascular bundles are small and located in two circles. Pith area is present at the center of the scape. The cells of the pith are parenchymatic and have no intercellular spaces. Pith cells are smaller than the cortex cells (Fig. 3A).

Leaf: Both adaxial and abaxial surfaces of *Iris iberica* leaves are covered by a cuticle. Epidermis is single-layered on both surfaces. Stomata are generally located on the adaxial side of the leaf and there are spaces under the stomata. Abaxial epidermis cells are bigger than the adaxial epidermis cells. The cells of the spongy and of the palisade parenchyma cannot be differentiated on the 5–7 layer mesophyll. The 2–3 layer mesophyll cells under the adaxial epidermis have more chloroplast. Vascular bundles are located closer to the abaxial epidermis (Fig. 4A,B).

I. sintenisii

Root: The cross section of the root has shown single-layered epidermis. The circular, oval and rectangular shaped cortex has intercellular spaces and is 19–21 cell layered. Endodermis is single-layered. The wall thickenings of the endodermal cells are three-sided and oriented towards the pericycle. Pericycle under the endodermis is single-layered and smaller in size than the endodermis cells. There are

7–8 metaxylems on the median part of the vascular cylinder. Xylem strands are present on the periphery of the vascular cylinder and they are nine in number. Pith area is absent in the root cross section (Fig. 2A,B)

Scape: Cross section of the scape has shown that the epidermis cells are covered with a thick cuticle. Epidermis is single-layered and formed of cells of nearly equal height and width. The 5–7 cell layered cortex has cells of 25–38 μm, oval and circular in shape. Intercellular spaces are present in the scape cortex. Different in size vascular bundles are located in three circles. Parenchymatic pith is consistent with the circular shaped cells and has intercellular spaces. Pith cells are larger than the cortex cells (Fig. 3B). These cells measure 50–75 μm (Table 1).

Leaf: Cuticle covers both the adaxial and abaxial surfaces of the leaves but it is thicker on the abaxial surface. Abaxial epidermis has papillae. Mesophyll cells are 3–7 layered. It is difficult to distinguish the cells of palisade parenchyma from the cells of spongy parenchyma on the leaf mesophyll. There are sclerenchyma groups on the abaxial part of the vascular bundles. (Fig. 4C,D,E)

Table 1. Anatomical measurements of *Iris iberica* **subsp**. *elegantissima and I. sintenisii*.

	Width (μm)		Lenght (μm)	
	Min.–max.	**Mean ± S.D**	**Min.–max**	**Mean ± S.D**
I. iberica* ssp. *elegantissima				
Root				
Epidermis cell	17–40	30±7.6	30–82	51±17.4
Cortex cell	17–35	26±6.8	18–52	36±13.2
Endodermis cell	20–27	24±2.4	32–42	36±3.7
Pericycle cell (diameter)	15–24	21±2		
Metaxylem (diameter)	40–70	54±13.2		
Scape				
Epidermis cell	15–18	16±0.9	15–23	19±2.5
Cortex cell	12–22	18±4.8	17–35	28±5.7
Trachae (diameter)	10–38	22±9.8		
Pith cell (diameter)	30–52	43±7.9		
Leaf				
Adaxial epidermis cell	12–25	18±4.8	15–32	21±6.4
Abaxial epidermis cell	15–28	20±4.1	17–25	21±2.5
Mesophyll	13–20	17±2.4	18–40	31±7.5
I. sintenisii				
Root				
Epidermis cell	25–45	30±7.35	17–25	21±3.24
Cortex cell (diameter)	25–38	30±4.29		
Endodermis cell	13–20	16±1.90	13–25	18±4.18
Pericycle cell	13–28	18±5.69	10–13	11±1.08
Metaxylem (diameter)	18–50	35±11.06		
Scape				
Epidermis cell	15–38	23±7.96	17–38	26±6.59
Cortex cell (diameter)	18–40	25±7.12		
Trachea (diameter)	13–18	15±1.87		
Pith cell (diameter)	50–75	58±2.44		
Leaf				
Adaxial Epidermis	13–20	15±2.23	15–20	18±1.89
Abaxial Epidermis	14–25	19±4.61	15–20	17±2.54
Mesophyll	15–43	32±12.5	13–28	18±5.44

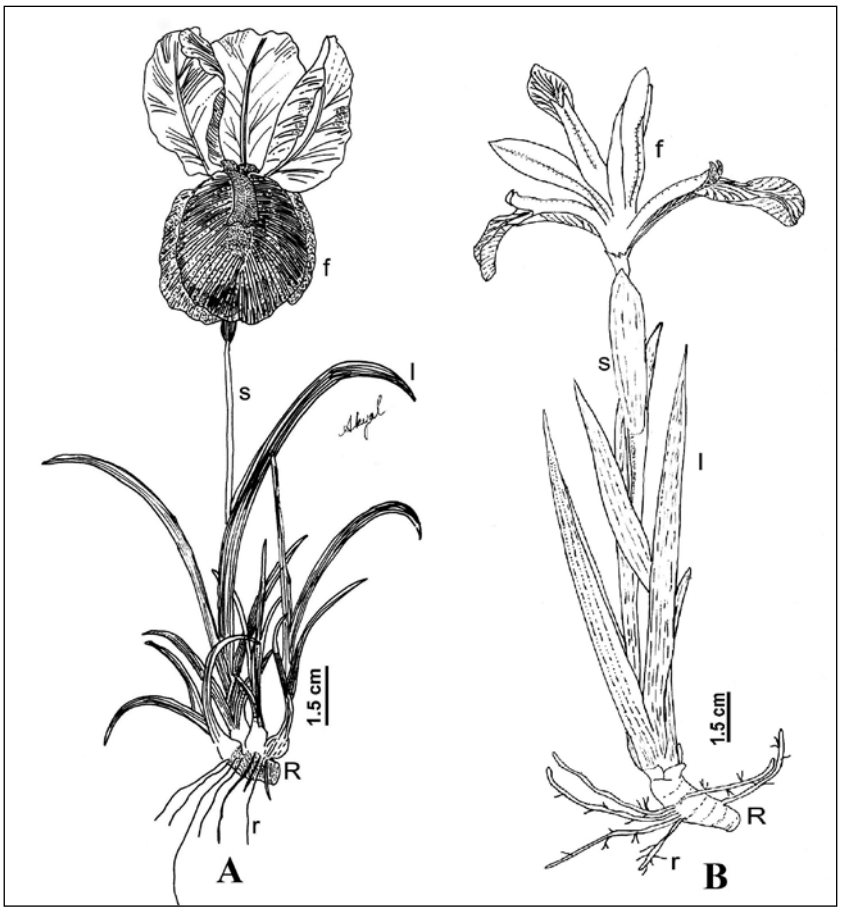

Fig. 1. General appearance of *I. iberica* (**A**) and *I. sintenisii* (**B**).
R: rhizome, **r**: root, **l**: leaf, **s**: scape, **f**: flower.

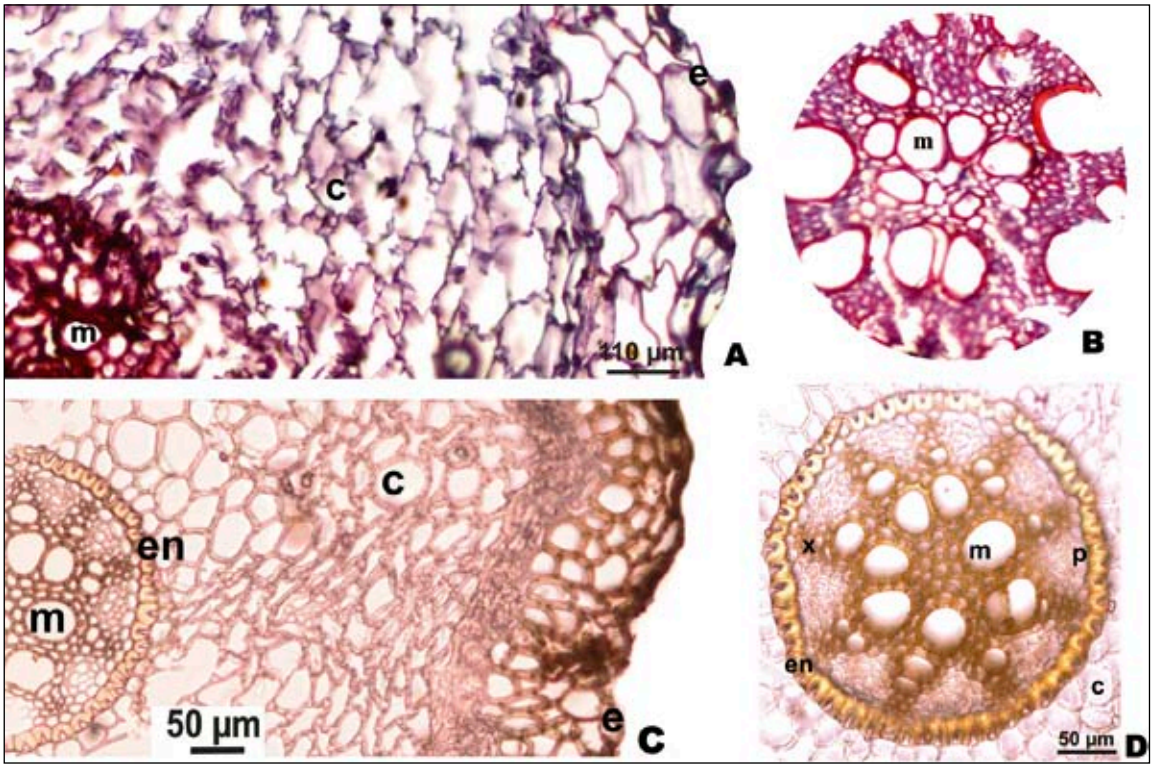

Fig. 2. Cross section of the root of *I. iberica* (**A**, **B**) and *I. sintenisii* (**C**, **D**).
C: cortex, e:epidermis, **en**: endodermis, **m**: metaxylem **p**: pericycle, **x**: xylem strands.

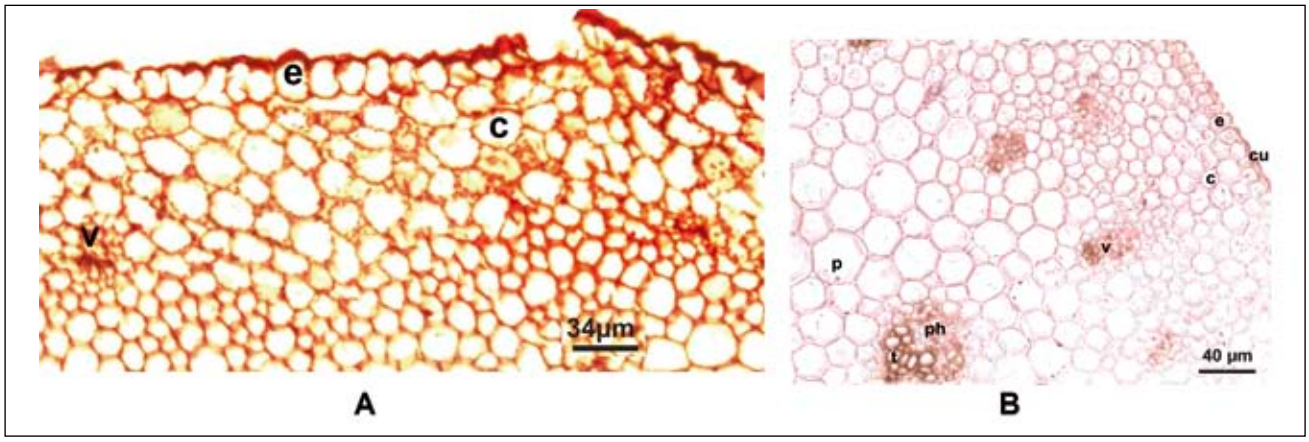

Fig. 3. Cross section of the scape of *I. iberica* (**A**) and *I. sintenisii* (**B**).
C: cortex, **cu**: cuticle, **e**:epidermis, **p**: pith, **ph**: phloem, **t**: trachea, **v**: vascular bundle.

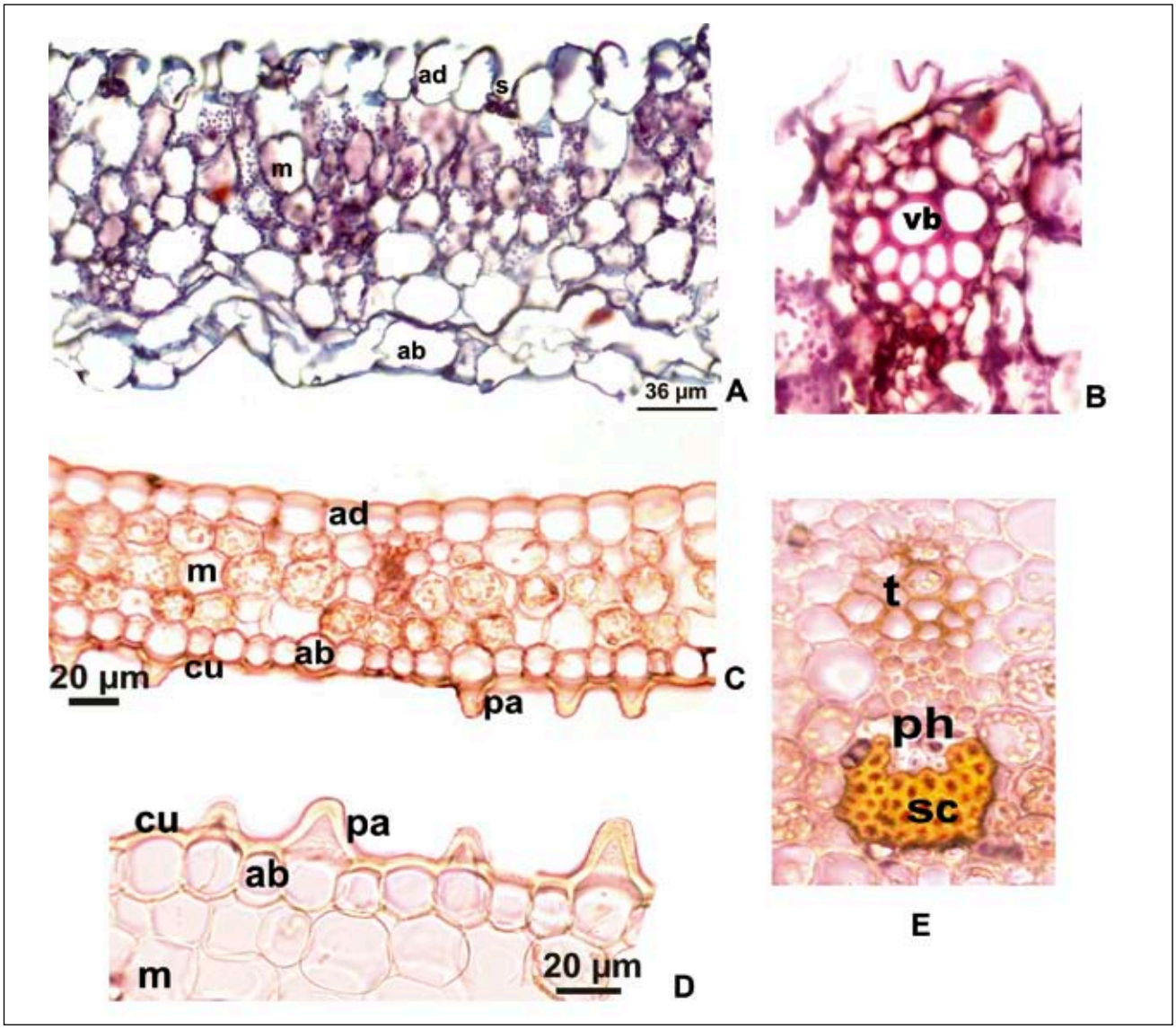

Fig. 4. Cross section of the leaf of *I. iberica* (**A**), vascular bundle (**B**); *I. sintenisii* (**C**, **D**), vascular bundle (**E**).
Ab: abaxial epidermis, **ad**: adaxial epidermis, **cu**: cuticle, **m**: mesophyll, **pa**: papillae, **ph**: phloem, **s**: stoma, **sc**: sclerenchyma, **t**: trachea, **vb**: vascular bundle.

Discussion

The morphological characters of the leaves, such as falls with a bearded claw or leaf shape, have taxonomical value for *I. iberica*. and *I. sintenisi*.

Anatomical structure of the roots of the two species is typically monocotyledonous. The thickening is clear in the walls of endodermal cells of *I.iberica* and *I. sintenisii*. These thickenings are three-sided and oriented towards the pericycle. The same feature was observed by researchers in the roots of some species belonging to *Iridaceae* and *Liliaceae* families, namely, *Crocus aerius* Herb., *Gladiolus atroviolaceus* Boiss., *Crocus danfordiae, Iris suaveolens* Boiss. & Reuter (Özyurt 1978; Özdemir & al. 2004, 2007). *I. sintenisii* has 7–8 metaxylem in the centre of the root, while *I. iberica* has 30–35 metaxylem. In the anatomical studies, nine xylem strands have been observed in the root of *I. sintenisii.* Fahn (1982) maintained that these xylem strands are polyarch. The same feature was observed by researchers in the root of *Merendera trigyna* (Adam) Stapf, *M. attica* (Spruner.) Boiss & Spruner (*Liliaceae*), *Crocus pulchellus* Herbert, *C. fleischeri* Gay, *C. danforiae* Maw (*Iridaceae*) and *Iris suaveolens* Boiss. & Reuter (Özyurt 1978; Özdemir & al. 2004, 2007).

Vascular bundles are arranged in three circles in the scape of *I. sintenisii* and in two circles in *I. iberica.* The same features have been observed in *Crocus aerius* Herb , *C. pulchellus* and *Hyacinthella glabrescens* (Özyurt 1978; Özdemir & Akyol 2004; Yetişen & al. 2012).

In *I. sintenisii,* cuticle covers both adaxial and abaxial surfaces of the leaf, but it is thicker on the abaxial surface, and abaxial epidermis has papillae. Özdemir & al. (2007) have observed papillae in the cuticle of *Iris suaveolens*, too. However, *I. iberica* has got no papillae. The palisade and spongy cells are not distinguishable in the leaves of *I.iberica* and *I. sintenisii.* Kutbay & al. (1993) and Özdemir (2003) have observed the same features in *Leucojum aestivum* (*Amaryllidaceae*) and *Lilium ciliatum* (*Liliaceae*). According to Mitic & al. (2000), leaf anatomical characteristics possibly correlate with the geographical coordinates and relate to the climatic conditions, especially to the xeromorphic or mesomorphic aspect of the habitat.Nikolic & Mitic (1991) had pointed out in some earlier investigations that the anatomical features of leaves could also be of diagnostic significance for some of the *Iris* species. It is known that anatomical characteristics could be of great importance for the taxonomy of the genus *Iris* and the family *Iridaceae* (Goldblatt & al.1984; Rudall 1994).

In conclusion, such leaf features as papillae, metaxylem number in root and arrangement of vascular bundles can serve as distinguishing characteristics for the *Iris* species.

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